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INTERFERENCE OF PENCILS WHICH CONSTITUTE THE REMOTE DIVERGENCES FROM A SLIT

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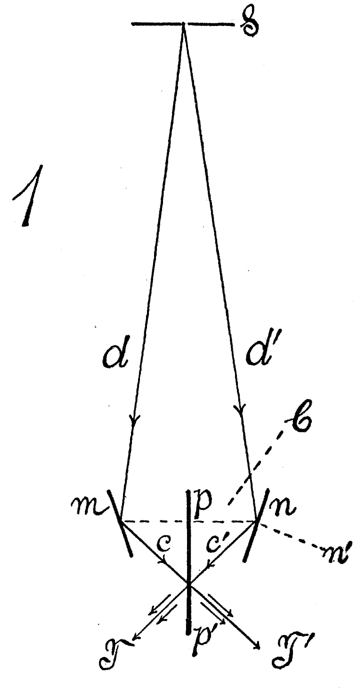
1. The sharp prism heretofore[2] used for cleaving the rays issuing from a collimator (or the slit simply) was dispensed with and the endeavor made to obtain two rays capable of interference. The assemblage of apparatus is shown in figure 1, where S is the slit (to be replaced by a Nernst or a tungsten filament), m and n the opaque mirrors, pp' the half silvered plate. The



rays dd', from S, pass after reflection into c and c' and may be observed by spectrotelescopes placed either at T or T'. In the first experiments the distance dp' was about 4 meters and the distance mn, 10 cm. The mirrors n and pp' were on micrometers with the screws normal to their respective faces. The distance mn must be within the limits of the wedge of light from the slit and is therefore small, unless d is very large. Both pp' and n are on the

rotating rail, whereas m is fixed. The apparatus was also adjustable for reversed rays by attaching an auxiliary mirror, normal to the rays d' prolonged through n. As S is distant, this slit must be long as otherwise the spectrum band will be a mere horizontal line and the fringes difficult to detect. A doublet of lenses each about 10 cm. in diameter, of the same focal power (1/60 cm.) but respectively convex and concave and having a combined focal distance of about 5 or 6 meters, is of advantage for focussing a large solar image (1 to 2 inches in diameter) on the slit. The Nernst or tungsten filament gives the same advantages at once, but the former is too thick.

The fringes are exceedingly difficult to find in spite of the brilliant spectra. It was not until after about three days of searching, in which besides sunlight I used the filaments as well as the methods of direct and of reversed rays that I ultimately succeeded with the former. The fringes lie quite sharply in a definite focal plane, usually between that of the slit image and the principal focal plane. After being found they are strong elliptic spectrum fringes; but when lost nevertheless difficult to rediscover.

The achromatics which coincide in adjustment with horizontal spectrum fringes and are seen with the slit image out of focus, are additionally difficult to find because of the short height of the slit image. As first obtained they lacked brilliancy and were not easily observed.

An attempt was made to register slight lateral displacements of the slit in terms of the displacement of fringes; but as the slit images are thrown out of coincidence when the slit moves, trustworthy numerical data could not be obtained. Incidentally it might appear that two vertical lines of the slit 0.0014 cm. apart should wipe out each other's fringes as a case of interference; but this is not the fact as slit widths over 100 times broader are admissible.

2. After completing these experiments, the distance between slit S and the mirrors mn was increased to about nine meters. The same lens doublet focussing a large solar image on the slit was used as before. When the fringes were found, in view of the longer distance, d, the slit could be opened to over a millimeter of breadth before they quite vanished, from the spectrum.

Operating with two successive slits at about 9 meters from the interferometer, one of which received the light through the other, I found that two independent sets of fringes very different in size and inclination could be put in the field together. Further investigation showed that the size and inclination of the fringes is essentially dependent on the degree of parallelism of the two corresponding slit images. When the images are parallel, the fringes are of maximum size and vertical. When the images are not quite parallel (they incline in opposite directions when the slit is slightly rotated in its own plane from the vertical), the fringes rapidly grow smaller, rotate and vanish. With parallel slit images the spectrum ellipses are centered in the field; otherwise they are very far out of center. The adjustment for actual (not x-like) coincidence must therefore be made with precision, if the fringes are to appear.

Further work was also done with sunlight to obtain more pronounced achromatics. For this purpose a compensator, C, was inserted to equalize the glass path in the half silvered plate. Huge spectrum ellipses were obtained in this way and their centers were placed above the telescopic field so that the fringes seen were large horizontal bars. On removing the spectroscope and placing the slit images out of focus, brilliant achromatics were now obtained, of the concentric hyperbolic type, vividly colored and broad between the apices, and diminishing to hair lines laterally. With these it was possible to enlarge the slit to at least 3 mm., without destroying the fringes, though they became more vague. It is again necessary that the slit images, when in focus, should be quite parallel. It was possible to place a plate of ground glass on the far side of the slit, without destroying the fringes; but not on the side towards the interferometer. In other respects the behavior was as described in the case of achromatics in the earlier experiments with a cleavage prism.

Finally the spectrum fringes and the corresponding achromatics were obtained with the light of a Nernst filament, by focussing an image of it with a strong condenser lens on the slit. The experiments however are very difficult. The spectrum fringes are often weak, out of focus and extremely sensitive to small disadjustments in the horizontal and vertical coincidence of the slit images. They require a fine slit. When well produced the achromatics are also obtainable on removing the spectroscope when the spectrum fringes are horizontal bars. The achromatics may also be obtained brilliantly without the condenser lens; but the adjustment must in such a case be made first with sunlight, as the spectrum from the Nernst filament is too feeble for detecting fringes so elusive as the present. The achromatics however are strong and brilliant even here (Nernst filament).

An interesting result is obtained in case of the achromatic fringes by narrowing one of the beams, for instance that coming from the mirror m (figure 1), by a screen with a slit about 2 mm. wide. In such a case the slit image, out of focus, is correspondingly narrowed. It may be passed from side to side of the broad washed slit image coming from the mirror n, by moving its adjustment screws (vertical axis). The fringes then appear only in a particular position of the narrow image in the field of the broader; but when they do appear they spread far beyond the margins of the narrow image on both sides. Interference thus apparently occurs where but one beam is present. The phenomenon is like those instanced before and means, as I understand it, that the beams have met in some other focal plane, though one is tempted to conclude that interference is stimulated by resonance, in particular as it is often impossible to find a plane in which they have met. The achromatics may sometimes be seen before and behind the principal focal plane, but more frequently either in the one or in the other region, only.

[1] Advance note from a Report to the Carnegie Institution of Washington.

[2] These PROCEEDINGS, 3, 1917 (565).